

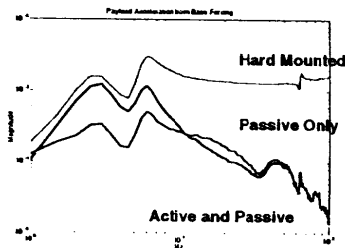
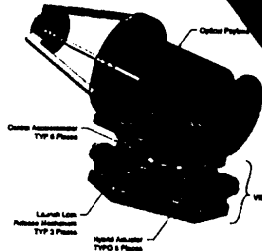
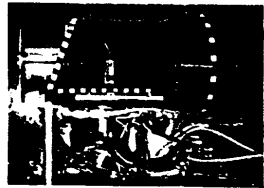
Vibration Isolation and Structural Control Technology for NGST

**Dr. T. Tupper Hyde
Honeywell Space Systems**

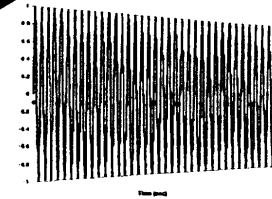
**NGST Technology Challenge
July 8-10, 1997**

Isolation & Structural Control Technology for NGST

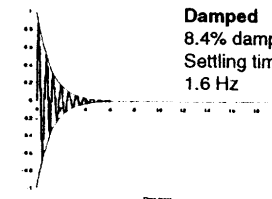
Payload Isolation



Tuned Mass Dampers



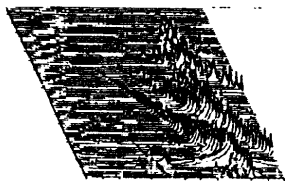
Undamped
0.1% damping
Settling time=11min
1.8 Hz



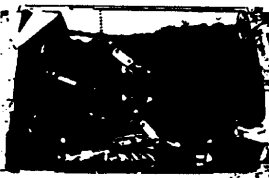
Damped
8.4% damping
Settling time=0.13 min
1.6 Hz



Reaction Wheel Isolation



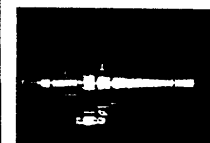
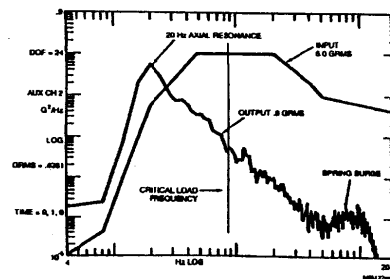
Force Isolation



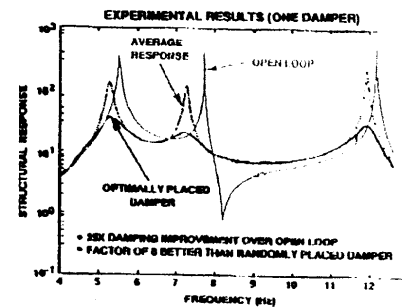
Vibration Force With Isolation



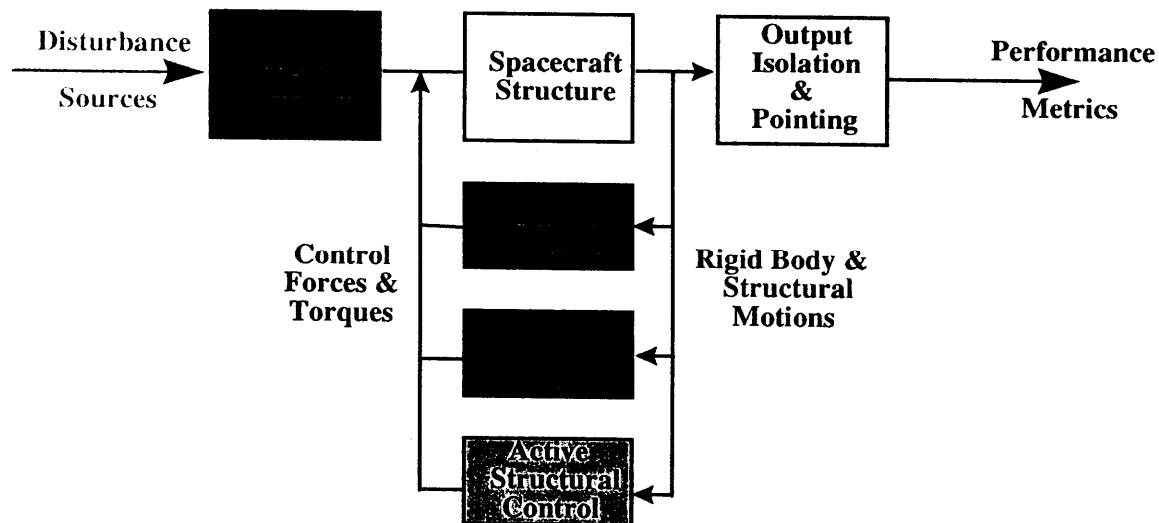
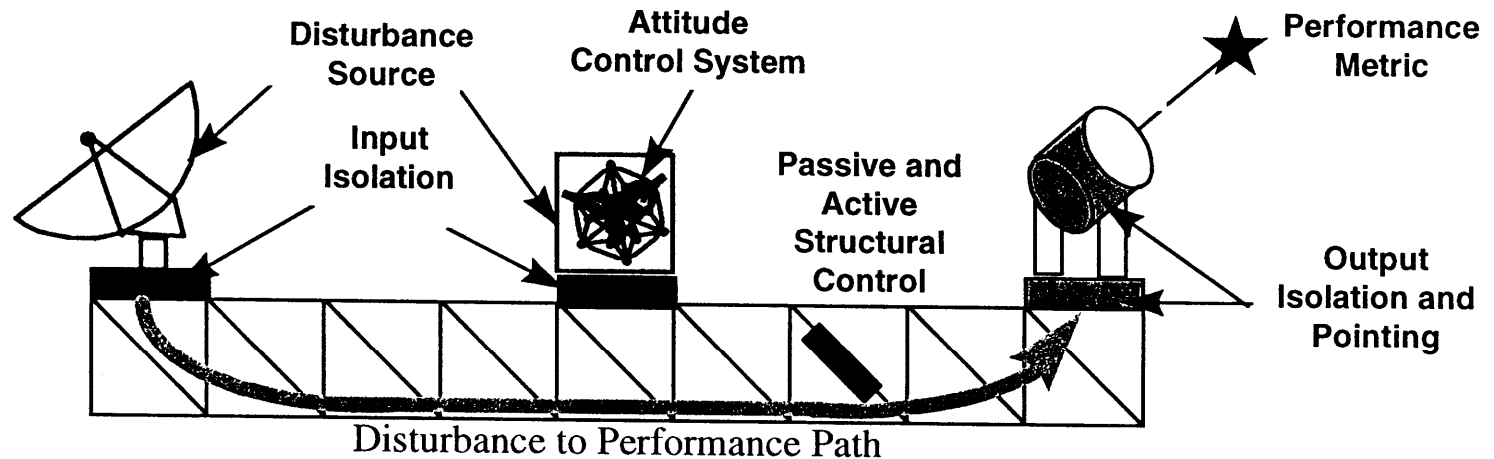
Launch Isolation



D-Strut™ Structural Dampers



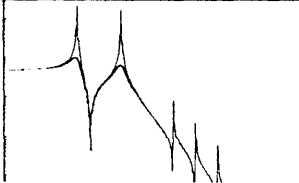

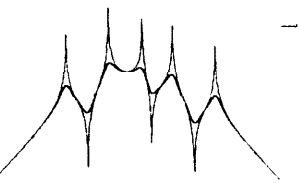
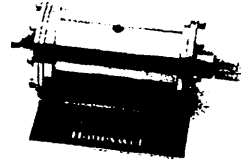

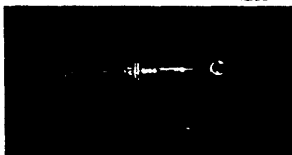
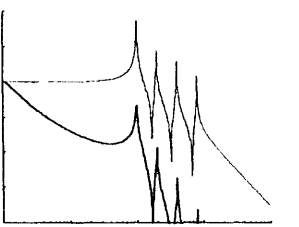
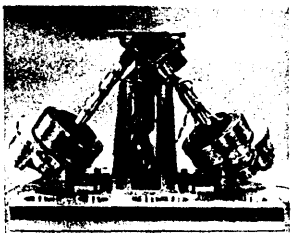

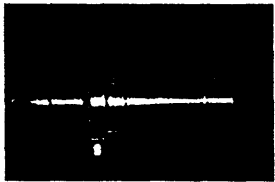
Control Structures Technology



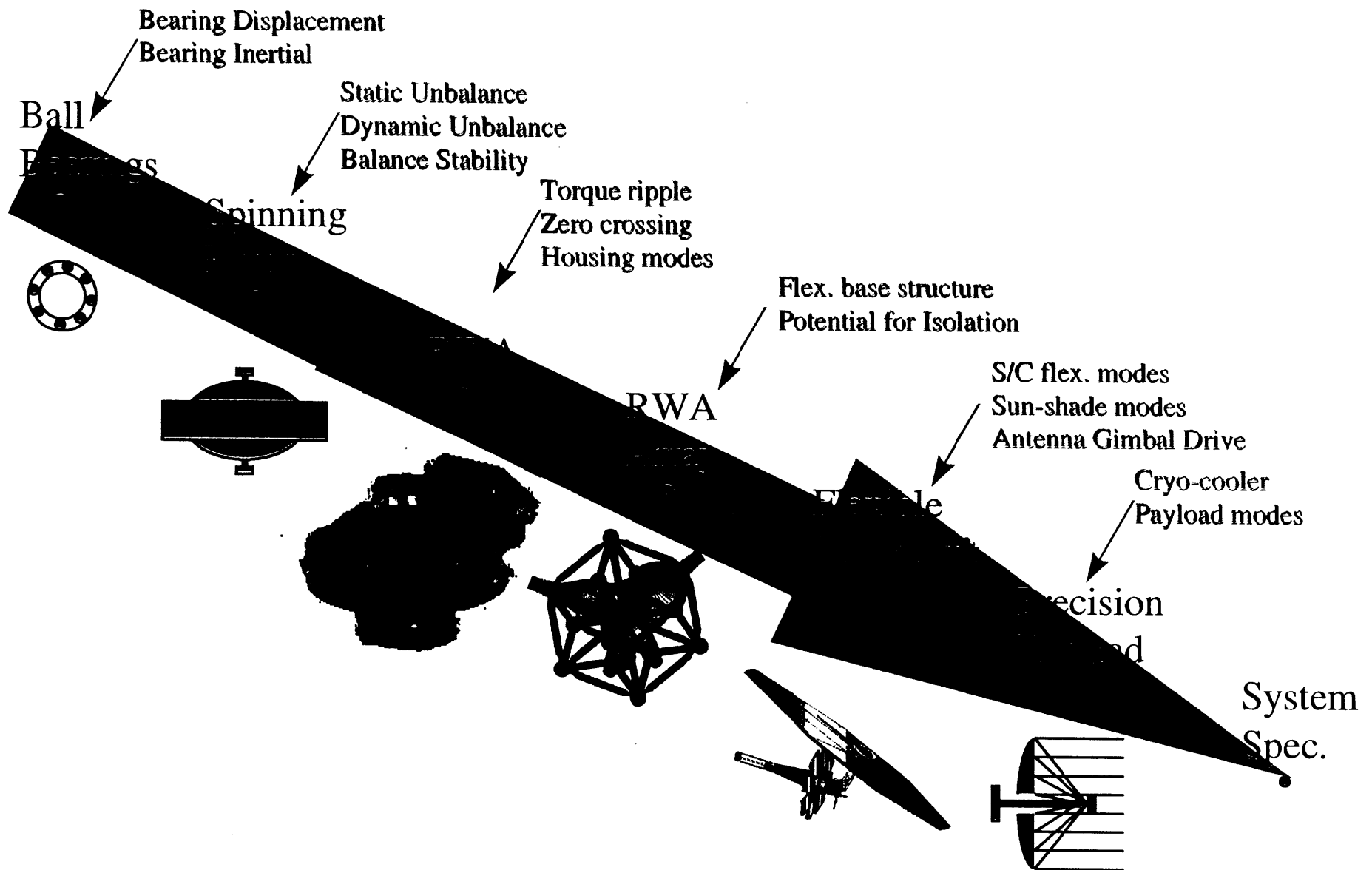
Contributors to the Problem

<i>Contributing Component</i>	<i>Potential Solution</i>
<ul style="list-style-type: none">• RWA Induced Vibration• Slew Disturbances• Sun Shade/ SA Modes• Lightly Damped Structure• Gimbal Motor Induced Vibration• Payload Modes• Thermal gradients• Cryocoolers	<ul style="list-style-type: none">Input IsolationCommand Shaping /Damped StructureDamped Structure/ TMDsIntegral DampingDisturbance IsolationPayload dampingActive Optical ControlForce Suppression

Vibration Problems and Solutions

Problem	Frequency Description	Solution	Product Application
A "few" appendage modes		Honeywell Tuned Mass Damper	
Many structural resonances		Honeywell D-Strut™ Structural Damper	
High frequency base motion		Honeywell D-Strut™ Passive Viscous Isolator	
Payload disturbance and pointing, low frequency base motion.		Honeywell Hybrid D-Strut™ Vibration Isolation, Suppression and Steering System (VISS)	
Launch induced vibrations on entire spacecraft		Honeywell Launch Vehicle Isolation System (LVIS)	

Jitter is a System Problem



D-Strut™ Viscous Isolation System Features

- High load capacity
- Linear performance over large dynamic range (10^5)
- Offers very high and adjustable damping rates
- Functions at ultra low vibration levels (50NM)
- Predictable performance
- Stiffness independent of Damping Coefficient
- Low temperature sensitivity compared to viscoelastic systems
- Long life free of any wear mechanisms
- Hermetic seal eliminates outgassing
- Basic features qualified for HST, Shuttle launch, DSP
- Low space application cost

Vibration Isolation and Steering (VISS) System

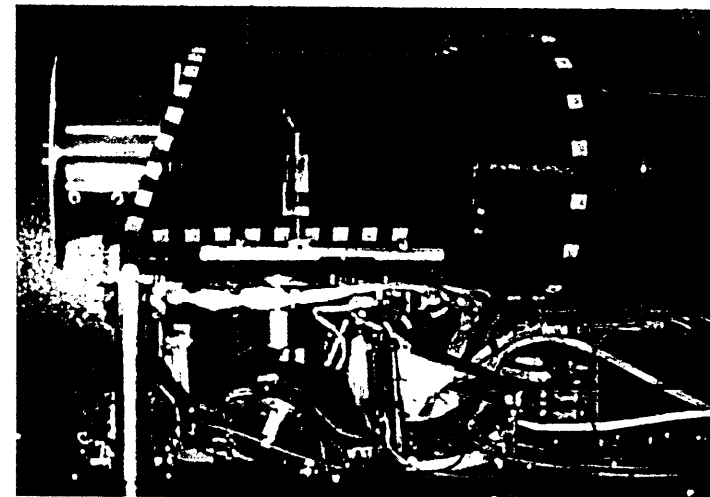
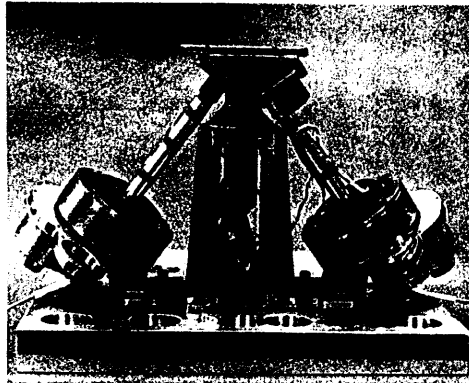
- Payload Weight : 33 lb.
- Payload Size : approx. 10 in dia. by 25 in. long
- System Weight (incl. 14lb electronics) : 34 lb.
- Bus Voltage : 28 VDC
- Peak Power : 50W
- Length of Strut : 8 in.
- Actuator Force : 2 lb.

Background and Performance

- Isolation > 20 dB for freq. > 5 Hz
- Dynamic Steering + 0.3 deg with accuracy of 0.02 deg.
- Suppression : > 20 dB for fundamental and first cryocooler harmonics (55 and 110 Hz)
- Undergoing Bench Tests at Phillips Lab
- Scheduled for Flight on STRV-2 in 1998

Applications

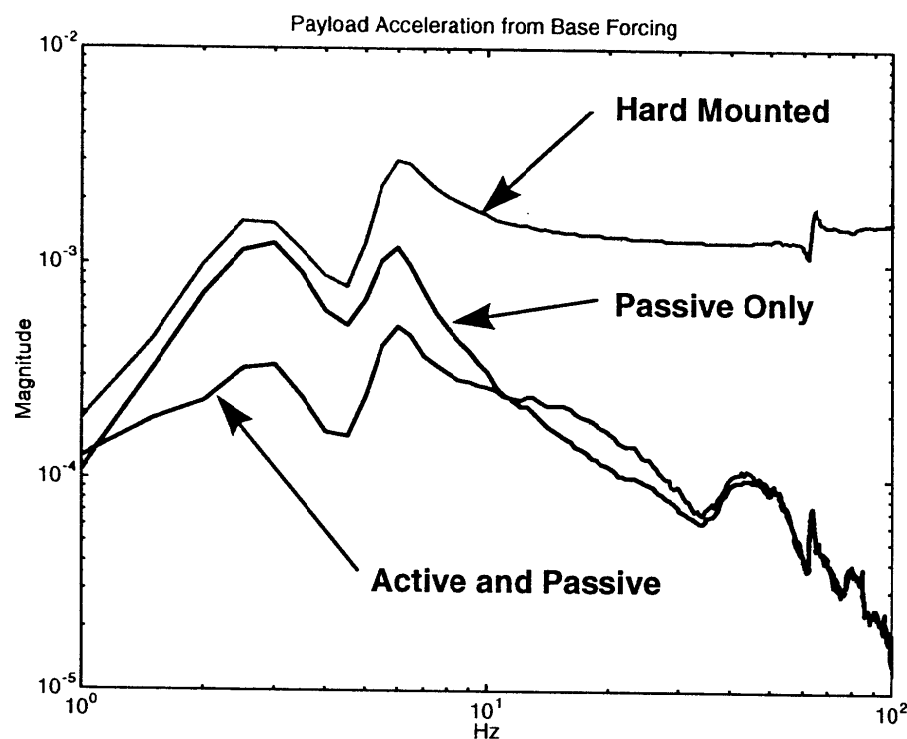
- *Optical equipment isolation*
- *Optical equipment precision pointing*
- *Jitter suppression*
- *Output Isolation*



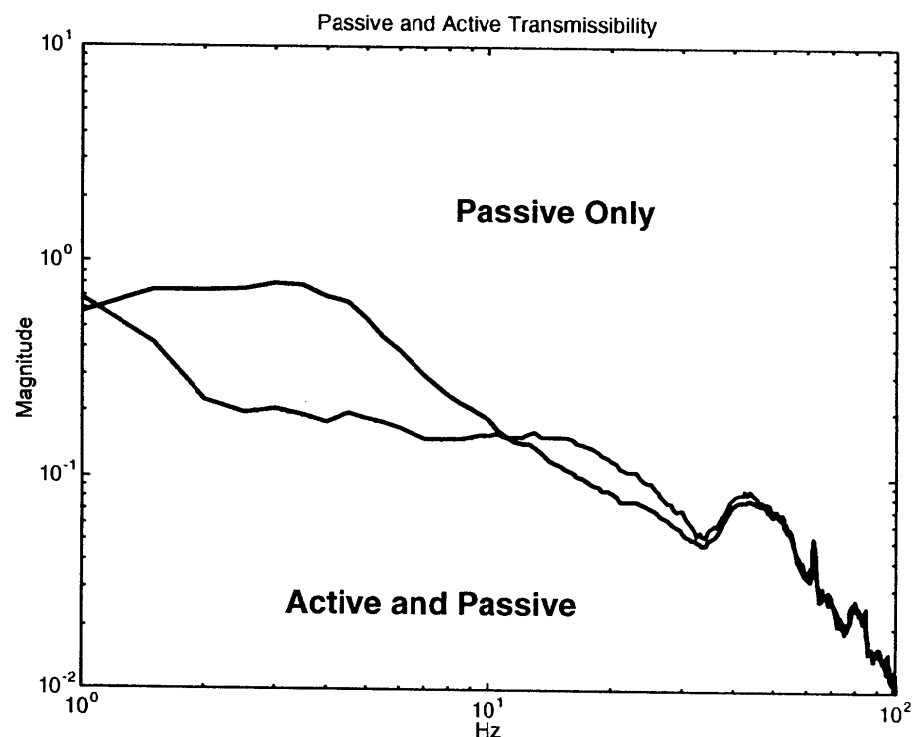
MWIR

6-axis
Hexapod
VISS

Experimental VISS Results



Payload Acceleration from Base Forcing



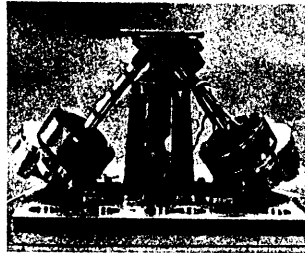
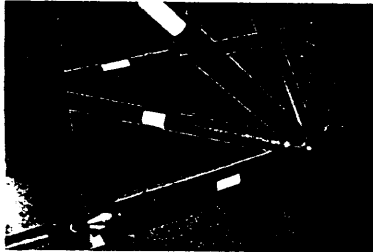
Passive and Active Transmissibility

6-axis Hexapod VISS Mounted to Optical Bench with
Induced Base Disturbance

Structural Control Testbed

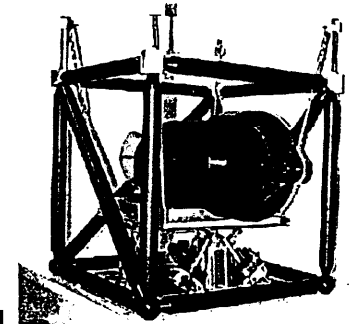
Passive Structural Control

- D-Struts™
- Tuned Mass Dampers (TMD)



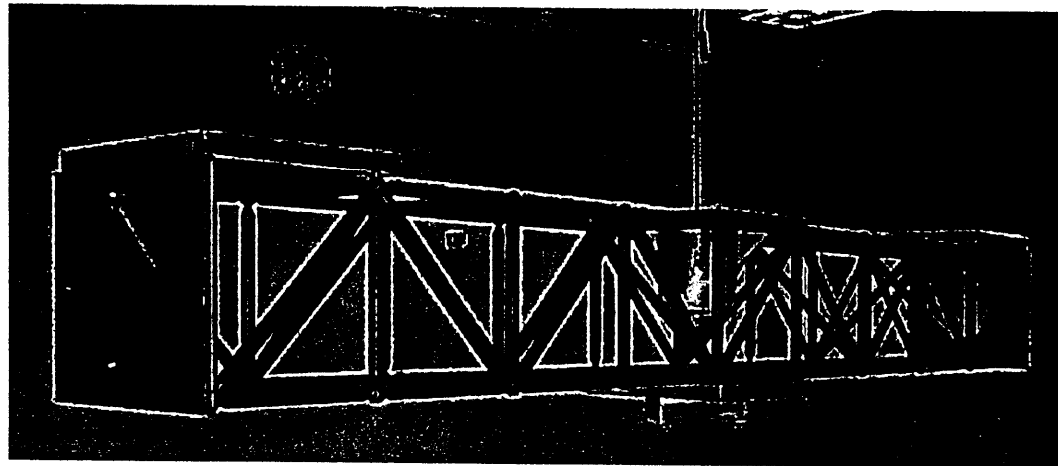
Active Structural Control

- Hybrid D-Struts™
- Proof Mass Actuators

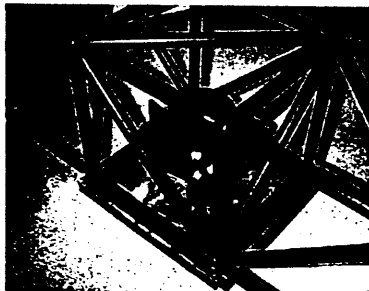


Precision Payload Isolation and Pointing

- VISS Hexapod
- Two-Axis Gimbal
- Inertially Stabilized Bench

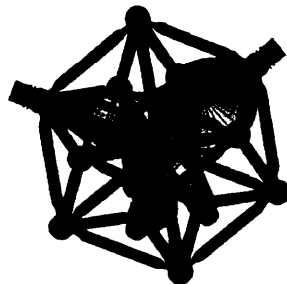


Representative Flexible Bus Structure



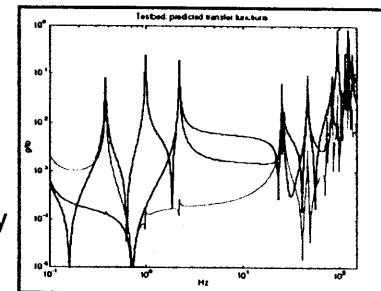
Attitude Control

- RWA/CMG's
- Momentum Systems
- Honeywell IMU's



Input Isolation

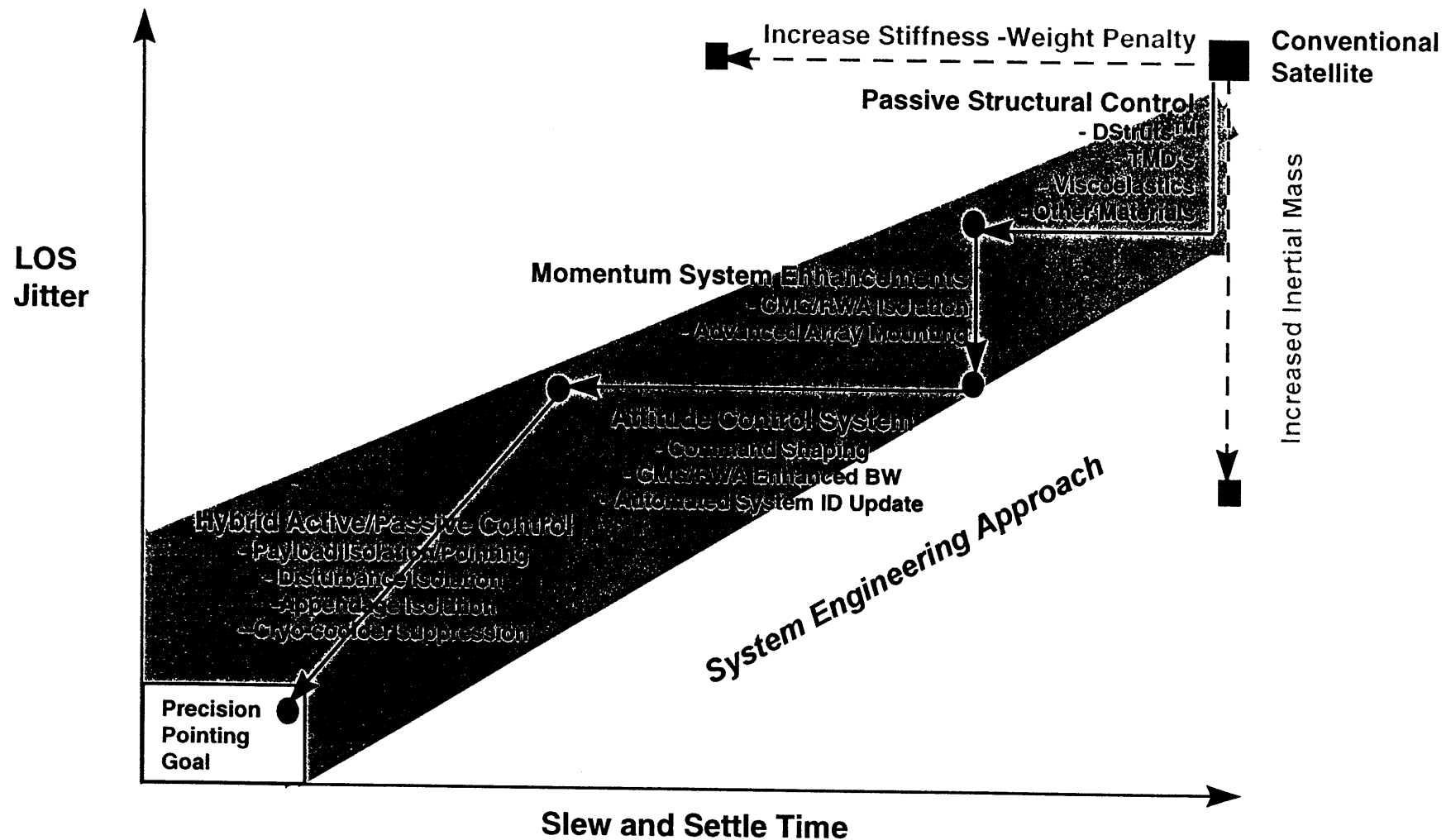
- Isolated RWA/CMG's
- Isolated Momentum Array
- SAD IV Reduction



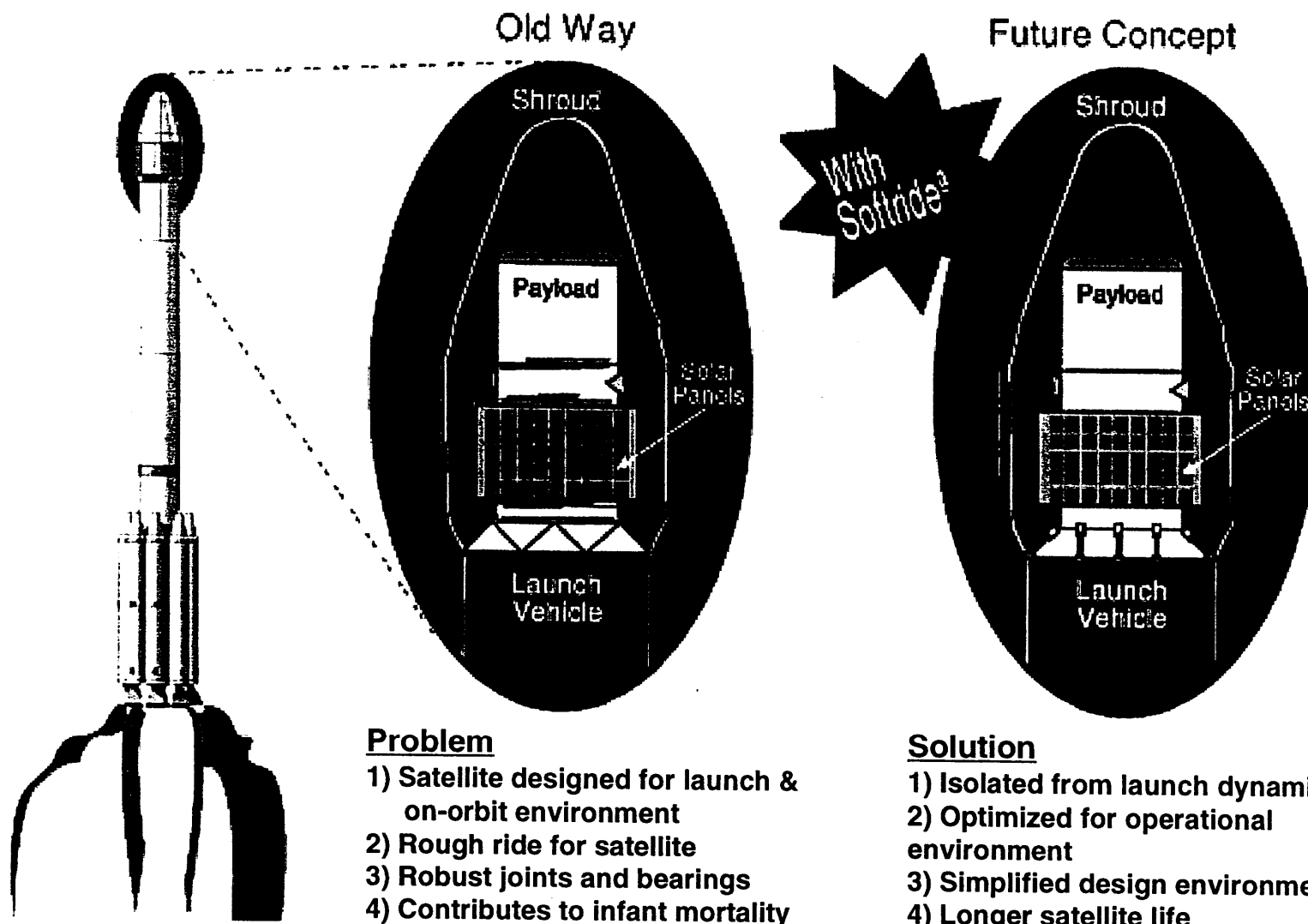
Structural ID/Control

- Autonomous Identification
- Command Input Shaping
- Modern Control

Precision Agile Spacecraft System Problem

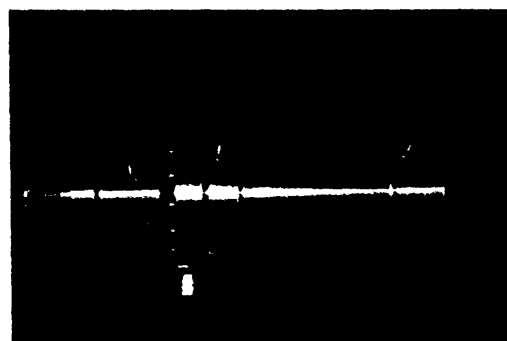
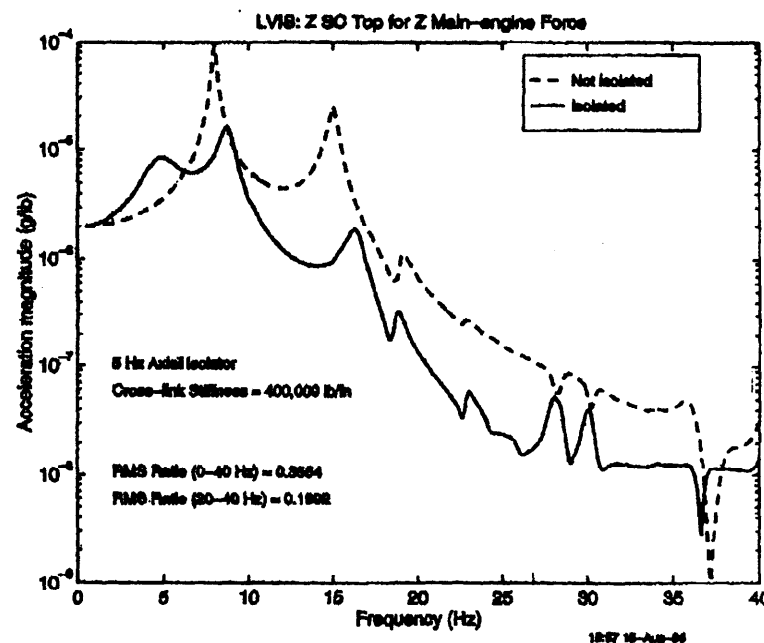
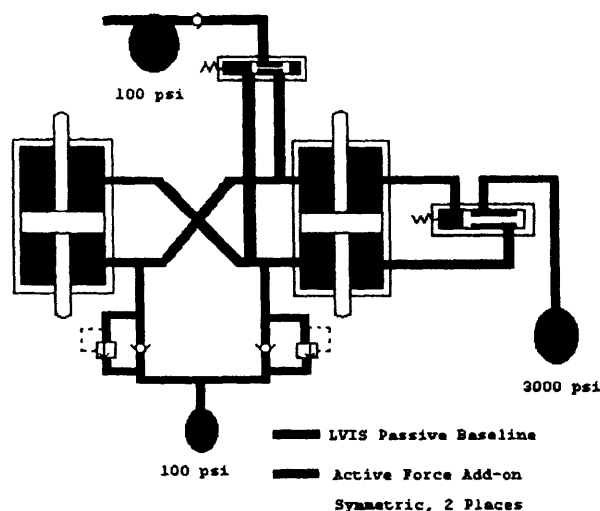


Satellite Launch Isolation



LVIS Launch Isolator

- Isolation System Weight : 19 lb. (47 current)
- Static Stiffness = 3970 lb/in.
- Cross-Link Stiffness = 400,000 lb/in.
- Damping : 107 lb-sec/in.
- Quasi-Static Load : 7500 lbs.
- Max Cross-Link Load : 4000 lbs.



Heavy Load Pneumatic Isolator

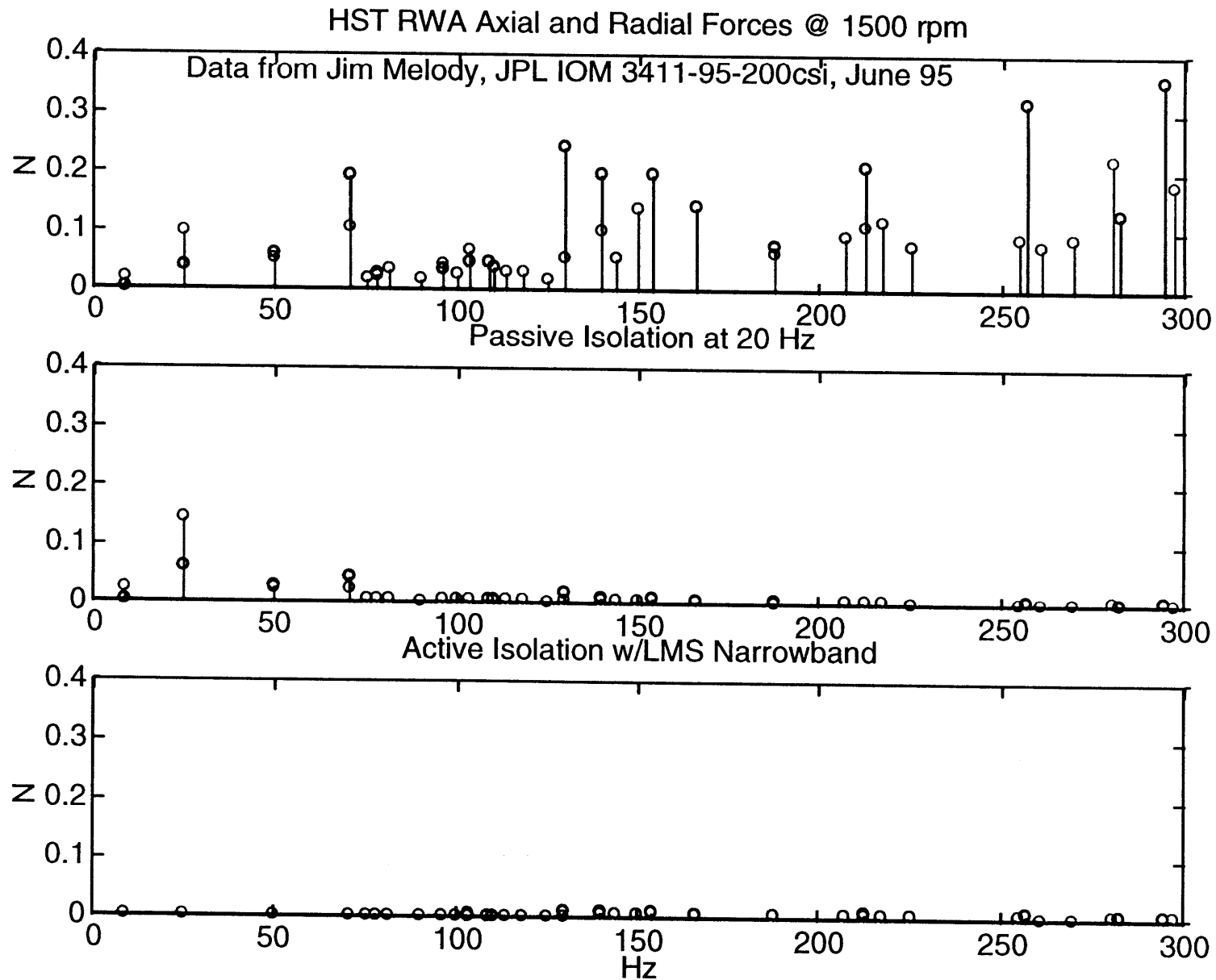
Applications

- Launch load isolation
- Airborne Bench Isolation
- Heavy Load Isolation

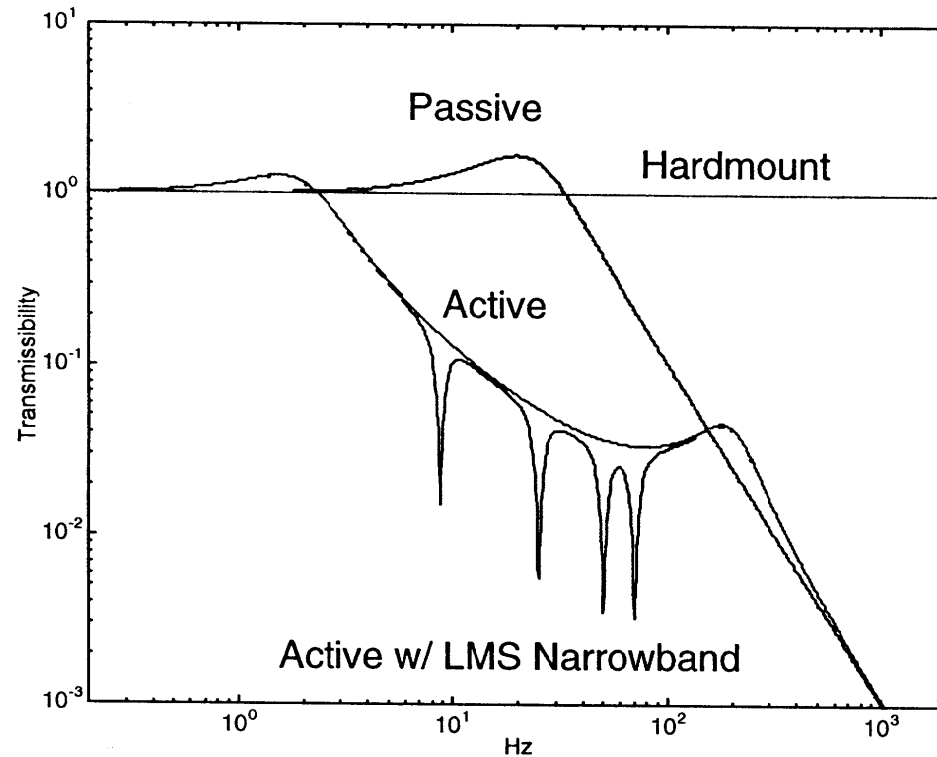
Experience and Capabilities

- D-Strut™ Three Parameter Passive Isolation products offer a low cost and proven approach to damping and vibration attenuation
- Honeywell has applied D-Strut™ isolation systems to Hubble Space Telescope and several other “real-world” spacecraft
- The active/passive Vibration Isolation and Steering System (VISS) has shown excellent test results for payload isolation.
- Launch load isolation systems using the LVIS isolation system have been shown to reduce both axial and lateral vibrations.
- Honeywell is currently integrating hybrid active/passive products and other new structural control technologies into an integrated testbed for fast slewing and settling of spacecraft systems
- Modeling techniques are being correlated to full scale test results for the integrated design of satellite structural control systems, discrete isolator placement and launch isolation

HST RWA Induced Vibration

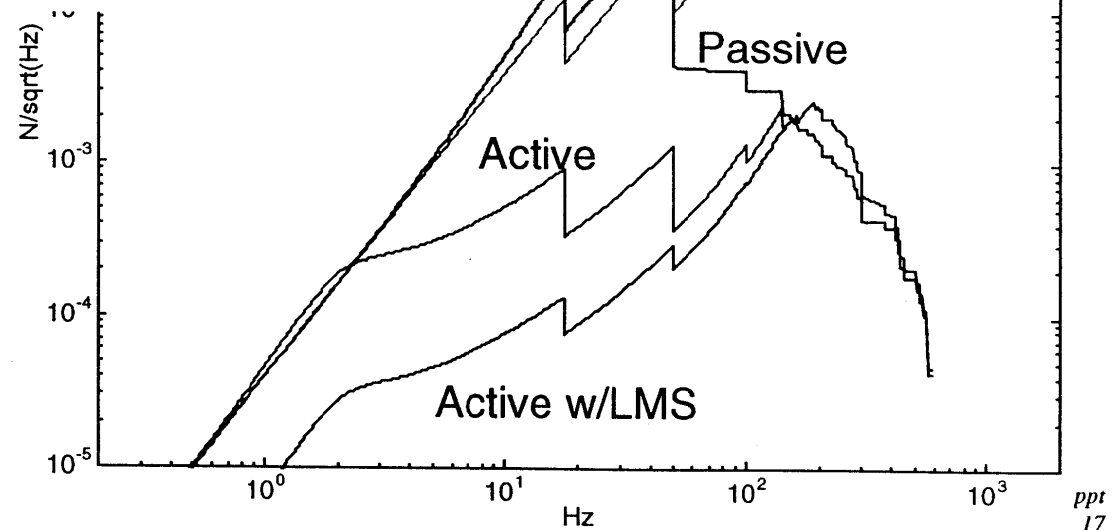


RWA Isolation

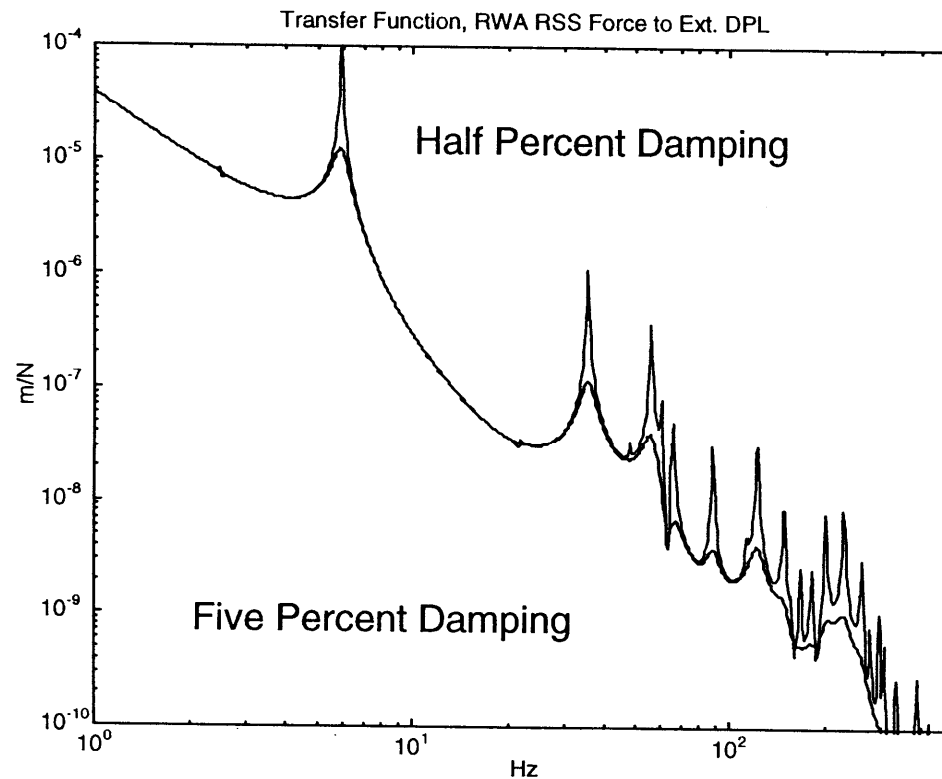


- 20 Hz, three parameter passive isolation
- Active isolation w/ first four harmonics -20dB

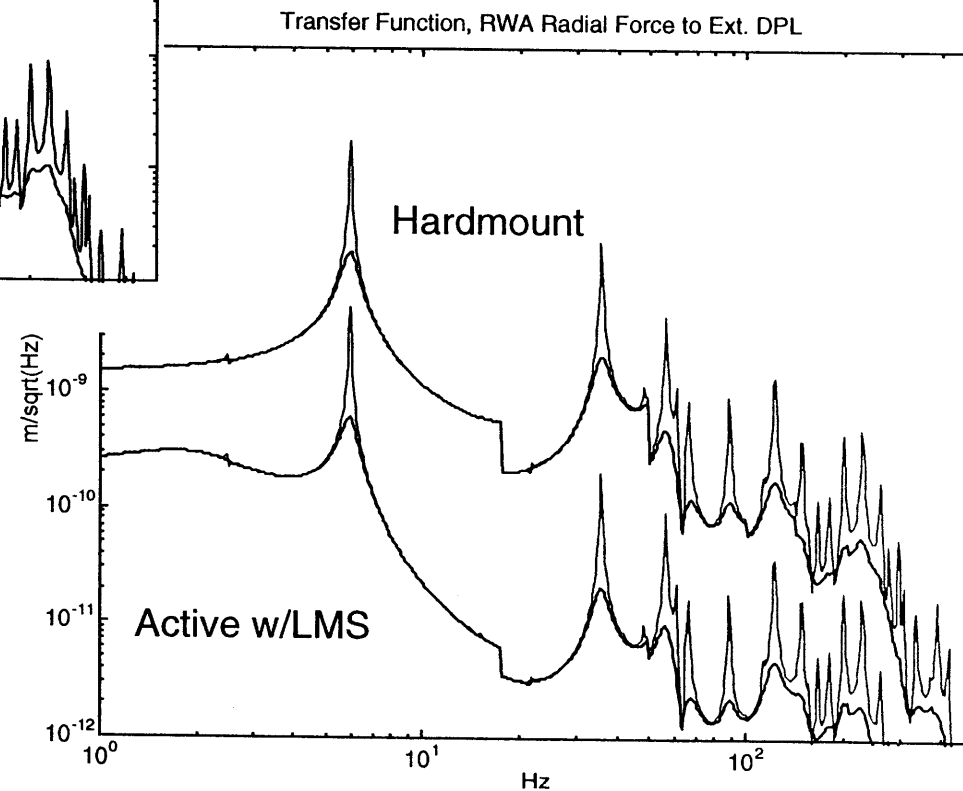
Stochastic Broadband Radial Forces [0,3000 rpm]



SIM Classic Dist. to Perf.



- RWA Axial Forces to Ext. DPL (Outer Siderostats Pair)

Ext. OPD (RMS 0-400 Hz)

Hardmount	78 nm
Hardmount/damped	24 nm
Isolated	3 nm
Isolated/damped	1 nm